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(54) **Mobile telephone and method to operate a mobile phone**

(57) The invention concerns a mobile telephone and a method to operate a mobile telephone that is working in the GSM frame structure. Each GSM frame has a lengths of 60/13 mms and is divided into 8 slots of equal lengths. A first slot is used to receive and a second slot is used to send radio signals. Within the frame structure a monitoring period of a lengths of at least 10/13 ms is allocated to monitor a code spread signal of a UMTS base station. Said monitor period has a fixed position in the time structure of the GSM frame.

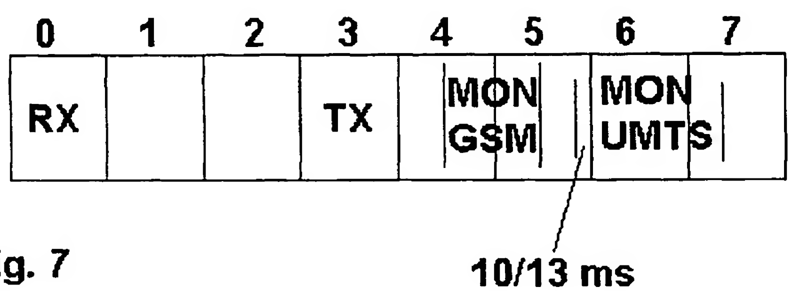

Fig. 7

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Description

State of the art

[0001] The invention concerns a mobile telephone and a method to operate a mobile telephone according to the generic features of the independent patent claims.

[0002] It is already known how a mobile telephone operates in the GSM frame structure thereby maintaining a telephone connection to a GSM base station. Further it is known how to access a UMTS base station.

Advantages of the invention

[0003] The mobile telephone and method to operate a mobile telephone according to the independent patent claims have the advantage that a current connection to a GSM base station can be maintained and at the same time the necessary information for a handover to a UMTS base station can be obtained from the UMTS base station. It is not necessary to interrupt the connection to the GSM base station to establish a connection to the UMTS base station. This does not require a second receiver in the mobile telephone.

[0004] Further advantages result from the features of the dependent patent claims. The monitoring period can be used to read the information of a primary synchronization channel, a secondary synchronization channel or a primary common control physical channel of the UMTS base station. Short monitoring periods can be used to obtain the information of the secondary synchronization channel of the UMTS base station. The monitoring period can be used together with a GSM monitoring period in the normal GSM structure.

Drawings

[0005] The invention is shown in the drawings and in described in greater detail in the following description. Figure 1 shows a GSM frame, figure 2 a UMTS frame, figure 3 a detail of UMTS frame, figure 4 the output of a matched filter, figure 5 and 6 a plurality of GSM frames and UMTS frames, figure 7, figure 8 and figure 9 GSM frames with monitor periods and figure 10 a mobile telephone, a GSM base station and a UMTS base station.

Description

[0006] Figure 1 shows the frame structure of a GSM frame. Such a GSM frame consists of 8 slots of equal lengths. The total lengths of the frame is 60/13 ms (4,615 ms) so that every slot has a lengths of 60/104 ms (0,576 ms). One of the slots is used for receiving information (rx) and one of the slots is used for transmitting information (tx). The transmitting slot tx is always 2 slots behind the receiving slot rx. This is shown in figure 1, where the slot numbering is given relative to rx time slot.

[0007] Figure 2 shows the frame structure of a UMTS frequency division duplex frame. The frame has a length of 10 ms and is divided into 16 slots of equal lengths each having a lengths of 10/16 ms (0,625 ms).

[0008] The invention is related to a dual band phone that is capable to operate into GSM system and into UMTS system. Acording to the invention such a telephone must not have 2 receivers to allow a seamless handover from the GSM system to the UMTS system. A seamless handover is an uninterrupted handover of a connection from a GSM base station to a UMTS base station. When the telephone is operating in the GSM mode it is necessary to monitor UMTS base stations to have the possibility to switch from a GSM base station to a UMTS base station. Such change from 1 base station to the other base station is called handover. Within the GSM system there are also handovers from one base station to the other base station. In order to perform such a handover the GSM frame structure normally has a GSM monitor slot which is used by the GSM phone to monitor other GSM base stations within the reach of the mobile telephone. The invention relates now to the handover from a GSM system to a UMTS-FDD system (frequency division duplex). Therefore there has to be the possibility to monitor in the GSM frame structure base stations that belong to the UMTS-FDD system. Such a monitoring is no problem if the mobile telephone has two receivers so that the mobile telephone is capable to receive signals from two different base stations at the same time. Since this is very expensive it is of advantage to have the possibility to use a mobile telephone that has only one receiver and is still capable to operate as a GSM telephone and is at the same time capable to monitor UMTS base stations.

[0009] To obtain the information that is necessary to perform a handover to a UMTS base stations of a mobile telephone has to perform three consecutive steps. This steps are called "initial cell search" since to mobile station acquires information of a UMTS radio cell. In the first step a slot synchronization of the UMTS slots is located, in the second step frame synchronization is obtained and in the third step a scrambling code is identified.

[0010] The first two steps are performed with the help of a synchronization channel of the UMTS base station. Such a synchronization channel having a primary synchronization channel and a secondary synchronization channel is shown in figure 3. The primary synchronization channel is spread by a primary synchronization code c_p. This primary synchronization code c_p is the same for every slot in every base station. As can be seen in figure 3 the primary synchronization channel is transmitted from the base station at the beginning of each UMTS slot and has a lengths of 10/160 ms (0,0625 ms). The secondary synchronization channel is coded with a secondary synchronization code c_s. This secondary synchronization code c_s is not the same for every slot. In the "High" index the first number indicates the slot specific code and the second number indicates the slot

number as shown in figure 3 for the first three slots. Since the secondary synchronization code vary from slot to slot within one frame it is possible to obtain a frame synchronization by reading this information.

[0011] For the first synchronization step the mobile telephone uses a primary synchronization code to identify the strongest base stations within reach. The mobile telephone uses a matched filter matched to the primary synchronization code to obtain the primary synchronization signal of all base stations. The output of such a matched filter is shown in figure 4. As can be seen there are signals of different intensity over time. The strongest signal indicates the base stations with the best link quality of all base stations. The strongest signal occurs every 10/16 ms thereby indicating the beginning of a new UMTS slot. From this information the base station has acquired slot synchronization of the strongest base stations. With the slot synchronization the mobile station knows when the slots of the strongest UMTS base stations start in time. In principle it is sufficient to know one the strongest base station. But it is also usefull to know a set of strong base stations. In case that the strongest has no capacity for a new mobile station is is then possible to access an other strong base station.

[0012] In the second step the mobile station monitors the signal of the secondary synchronization channel. The mobile station has to read the secondary synchronization signal of all slots of a frame in order to be capable to identify the different variations of the secondary synchronization code that indicate the different slots in the frame. From the sequence of the secondary synchronization codes the frame synchronization can be derived.

[0013] For cell search it is of interest to read the information of a complete UMTS frame. Since the UMTS frame has a lengths of 10 ms, a time period of more than two GSM frames is needed to read a whole UMTS frame. Under the assumption, that the information in the UMTS frame does not vary from frame to frame, there is another possibility to read the information of a total frame. This is illustrated with the help of figure 5 and 6.

[0014] Figure 5 shows the two frame structures of the GSM system and the UMTS system in comparison. 13 consecutive GSM frames have a lengths of 60 ms. 6 consecutive UMTS frames have a lengths of 60 ms as well. It is therefore possible to use in the GSM frame structure a monitoring period with the lengths of 1/13 of the UMTS frame to reconstruct a UMTS frame. This method allows to reconstruct one UMTS frame every 6 UMTS frames. Of course as this reconstructed frame is not a measurement of a single UMTS frame but an reconstructed frame that combines measurements of a different parts of 6 consecutive UMTS frames to reconstruct one UMTS frame. For using this method it is therefore necessary that the information that is monitored does not change over 6 consecutive UMTS frames.

[0015] Figure 6 shows again 13 GSM frames and 6 UMTS frames. Further the relative positions of the monitoring period is shown. The position is relative, because the position of the frame borders of the GSM frame relative to the frame borders of the UMTS frames are shown. The end of GSM frame 11 indicates the measurements of the first 13th of a UMTS frame. The end of frame 9 indicates the measurement of the second 13th of a UMTS frame. The end of GSM frame 7 indicates the measurements of the third 13th of the UMTS frame. By using a measurement period in the GSM frame structure that has a fixed position relative to the frame borders and a lengths of 1/13th of a UMTS frame, it is therefore possible to reconstruct a complete UMTS frame out of 6 consecutive UMTS frames. This method therefor allows to obtain the information that is needed for a handover from the GSM system to the UMTS system without interrupting the data transfer in the GSM system.

[0016] Figure 7 shows how the UMTS monitoring period is fitted into a GSM frame. Figure 7 therefor shows a GSM frame comprising of 8 slots. The first slot (number 0) is used for receiving data the fourth (number 3) is used for sending data and in the remaining four slots a length of one slot is used for monitoring a GSM base stations and a further time period having a length of 10/13 ms (that is a period that is longer than a GSM slot) is used for monitoring a UMTS station. Essential is that the monitoring period of the UMTS system has a length of at least 10/13 ms, that this monitoring period is repeated for 13 consecutive GSM frames and that the time difference between the UMTS monitoring period and the begin or end of the 13 consecutive GSM frames is always the same in each of the thirteen frames. Then it is possible to reconstruct a complete UMTS frame from 6 UMTS frames.

[0017] The method is especially useful for a single receiver mobile station that has to change the frequency of the reception part of the mobile station depending on which signal it has to receive. The mobile station must have the capability to change the frequency of the receiver fast enough to allow the receiver to change from receiving data to monitoring a GSM base station and then change again to monitor a UMTS base station. In figure 7, which shows a monitoring period of a GSM base station and monitoring period of a UMTS base station that are used within four consecutive GSM slots, the requirements in frequency agility of the receiver are very high.

[0018] Figure 8 shows further possibility to place a UMTS monitoring period in a GSM frame structure under the assumption that there is no further GSM monitoring period needed in the frame. The frame as shown in figure 8 has a receiving slot number 0, a transmitting slot number 3 and has then a period of 4 GSM slots wherein the UMTS monitoring period can be located. The requirements to the receiver to change the frequency is therefor much more reduced. A drawback of this solution is that the GSM monitoring period has to be skipped for 13 consecutive GSM frames.

[0019] Figure 9 shows a further GSM frame in which

the slot 0, 3 and 5 are the same as shown in figure 1. Within the GSM slots 4 and 6 are short UMTS monitoring periods that have a lengths of 10/160 ms (0,0625 ms) and are separated from each other by 10/16 ms (0,625 ms). With these two monitoring periods it is possible to monitor the secondary synchronization channel if the starting point of this synchronization channel in time is known.

[0020] Figure 10 shows a mobile telephone working according to the invention that is capable to connect to a GSM base station 2 or to a UMTS base station 3. The mobile telephone 1 comprises an antenna 4 which is used to exchange radio signals (as indicated by the arrows) with the antennas 4 of the base stations 2, 3. The invention relates to a mobile telephone 1 that is already in connection to a GSM base station 2 therefore radio signals are exchanged with a GSM frame structure as shown in figure 1. For performing a handover from the GSM base station 2 to the UMTS base station 3 the mobile telephone 1 must have the possibility to continue a running telephone connection with the GSM base station and at the same time acquire information from the UMTS base station that is needed to handover the connection from the GSM base station 2 to the UMTS base station 3. The invention concems how monitoring periods from monitoring the UMTS base station 3 are fitted into the GSM frame structure.

Claims

1. Mobile telephone working in the GSM frame structure, each frame having a length of 60/13 ms (appr. 4,615 ms) being divided into 8 slots of equal lenth, using a first slot to receive and a second slot to send radio signals,
   characterized in, that a monitoring periode of a lenght of at least 10/13 ms (appr. 0,7692 ms) is used to monitor a code spread signal of a UMTS base stations and that said monitor periode has a fixed position in the time structure of the GSM frame.

2. Mobile telephone according to claim 1, characterized in, that in said monitor periode a matched filter uses a primary synchronisation code to despread a primary synchronisation channel of a plurality of base stations, from said despread primary synchronisation channels a set of strongest channels are selected for obtaining a slot synchronisation of the set of base stations of said base stations.

3. Mobile telephone according to claim 1, characterized in, that in said monitor periode a secondary synchronsation channel of a base station is despread to obtain a frame synchronisation to the base station.

4. Mobile telephone according to claim 1, characterized in, that in said monitor periode a Primary Common Control Physical Channel of a base station is despread to obtain a scrambling code of the base station.

5. Mobile telephone according to claim 2, characterized in, in that the slot synchronisation obtained from said primary synchronisation channel is used to obtain a frame synchronisation to the base station by short monitoring periodes having a lenght of at least 10/160 ms (0,0625 ms).

6. Mobile telephone according to the preceding claims, characterized in,, in that the GSM frame comprises only the first slot to receive, the second slot to send and the monitoring periode.

7. Mobile telephone according to claims 1 - 5, characterized in, in that the GSM frame comprises the first slot to receive, the second slot to send, a third slot to monitor a GSM base station and the monitoring periode.

8. Methode to operate a mobile telephone working in the GSM frame structure, each frame having a length of 60/13 ms (appr. 4,615 ms) being divided into 8 slots of equal lenth, using a first slot to receive and a second slot to send radio signals, characterized in, that a monitoring periode of a lenght of at least 10/13 ms (appr. 0,7692 ms) is used to monitor a code spread signal of a UMTS base stations and that said monitor periode has a fixed position in the time structure of the GSM frame.

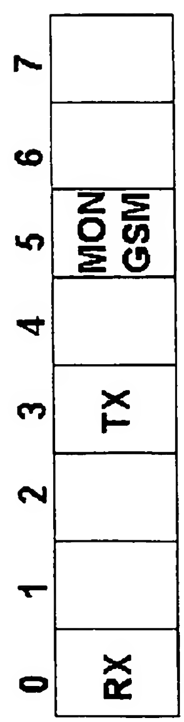


Fig. 1

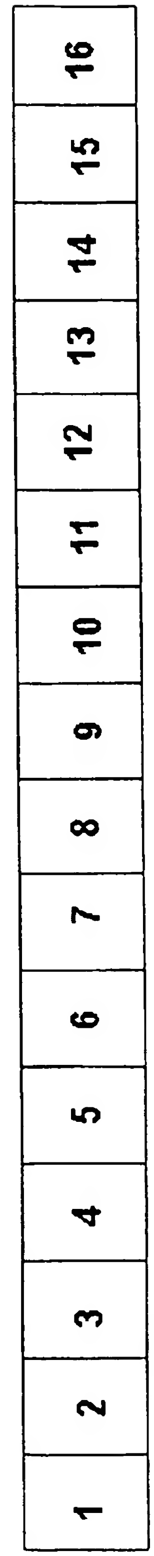


Fig. 2

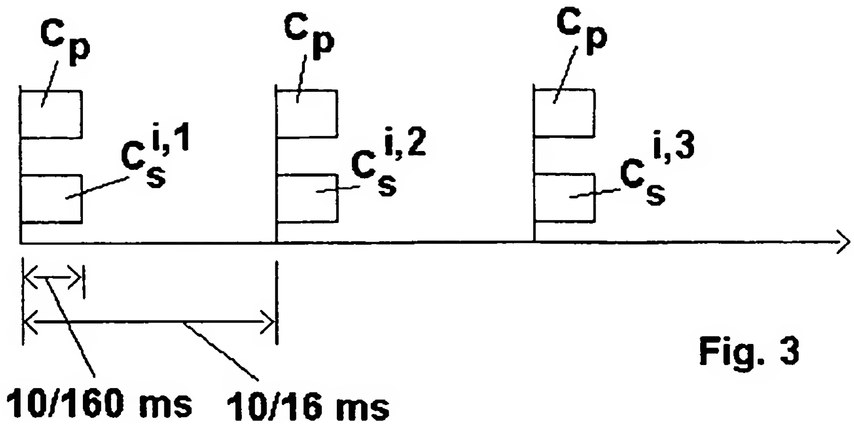


Fig. 3

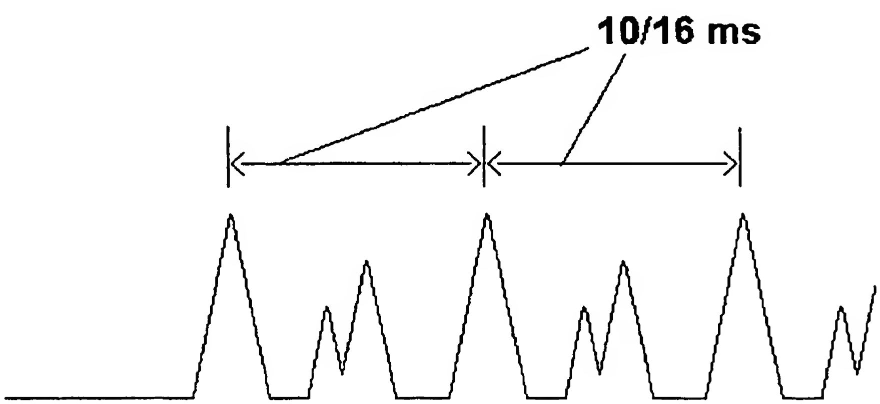
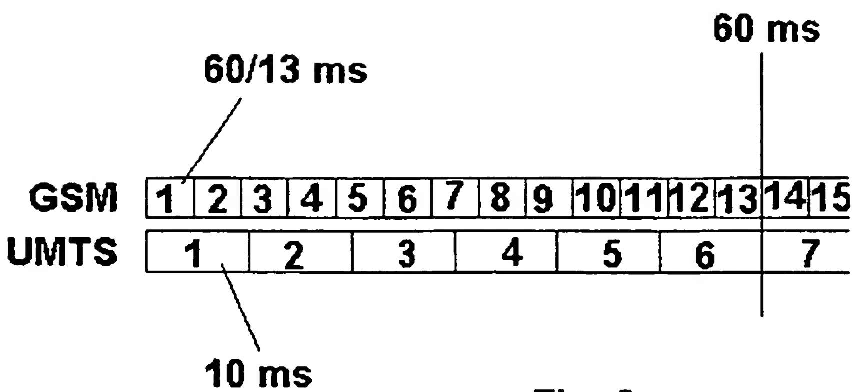


Fig. 4


60 ms
60/13 ms
GSM
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
UMTS
1
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3
4
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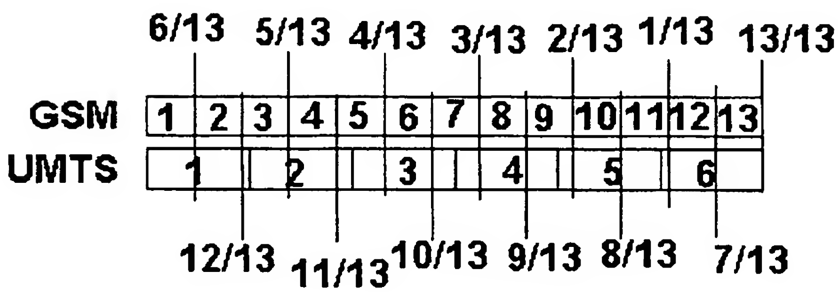
6
7
10 ms

Fig. 5


6/13
5/13
4/13
3/13
2/13
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13/13
GSM
1
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UMTS
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Fig. 6

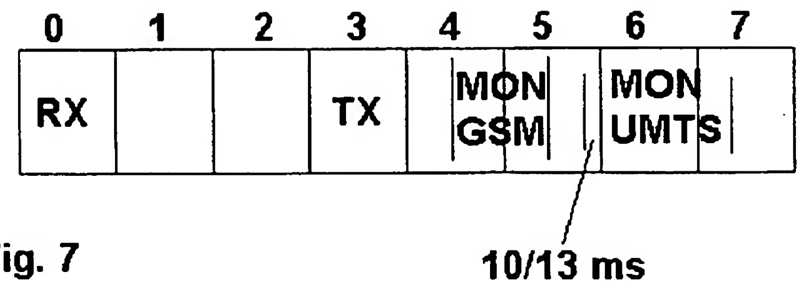

Fig. 7

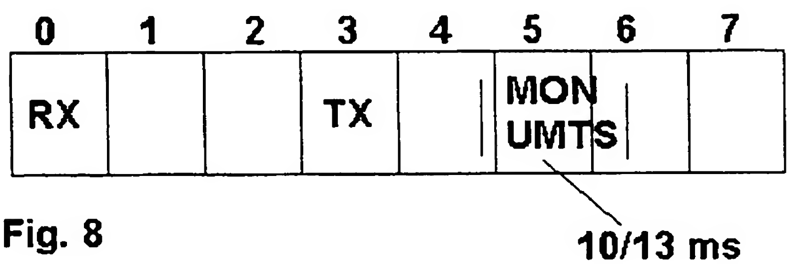

Fig. 8

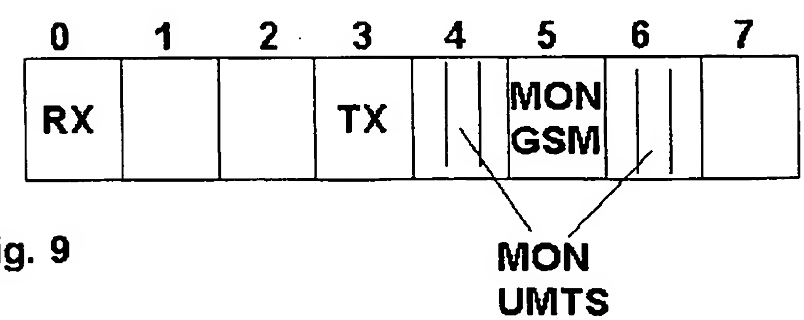

Fig. 9

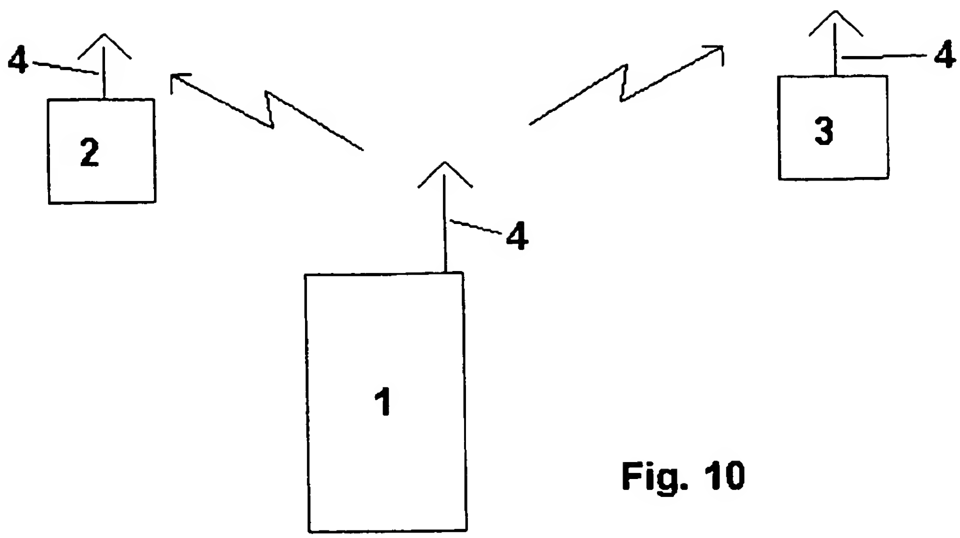

Fig. 10

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 11 2381

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	DE 197 46 894 A (SIEMENS AG) 29 April 1999 (1999-04-29) * abstract * * column 4, line 63 - column 5, line 16 * * column 6, line 10-15 * * column 6, line 23-50 * * figures 1,10 * * claim 1 *	1,8	H04Q7/38
A	WO 95 31879 A (NOKIA MOBILE PHONES LTD ;NOKIA TELECOMMUNICATIONS OY (FI); JOKINEN) 23 November 1995 (1995-11-23) * page 14, line 24 - page 15, line 8 * * figures 1,9 *	1,8	
A	DE 196 00 197 C (SIEMENS AG) 22 May 1997 (1997-05-22) * abstract * * column 1, line 58 - column 2, line 1 * * figures 1,5 * * claims *	1,8	

DOCUMENTS CONSIDERED TO BE RELEVANT

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H04Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	3 November 1999	Dejonghe, O

CATEGORY OF CITED DOCUMENTS

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03-11-1999

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